ATLAS NOTE

ATL-PHYS-PUB-2006-000

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A pre-commissioning `-cross section measurement at ATLAS`

The ATLAS Collaboration

Abstract

This paper is a template ATLAS paper.

1 Introduction

Motivation+Method

2 Event selection

We use the inclusive electron streaming dataset, generated from a mixture of physics processes simulated in release 11.0.42. The dataset corresponds to a nominal luminosity of 18 pb^{-1}.

2.1 Cuts

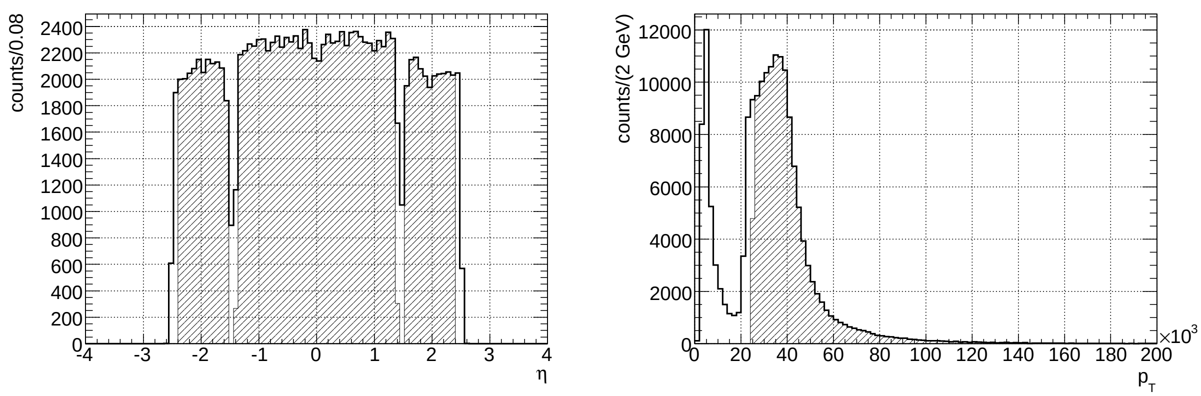
This section describes our object-level cuts that define what we call an "electron" and a "jet"; then describes the event-level cuts that we use in this study.

Electron definition

Electron is an object from an `ElectronContainer` with the StoreGate key *ElectronCollection*, which satisfies:

1. AuthorEgamma,
2. $|eta| < 2.4$ and $|\eta| \notin [1.37, 1.52]$,
3. $p_T > 25$ GeV.

Distributions of the p_T and η cut variables are shown on Fig. 1.



(a) (b)

Figure 1: Distributions of η (1(a)) and p_T (1(b)) of electron candidates. The η distribution includes only those the candidates that passed the p_T cut, and p_T distribution only the candidates that passed the η cut.

Jet definition

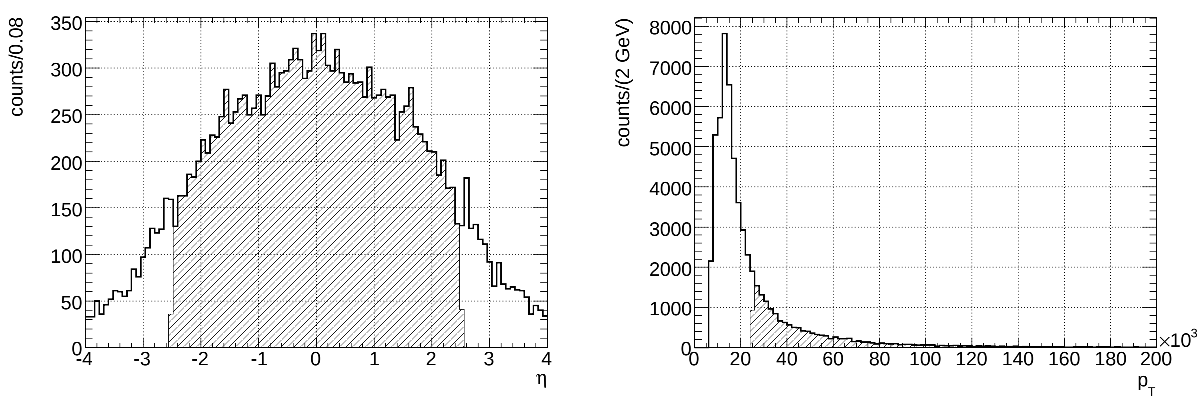
Jet is an object from an `ParticleJetContainer` with the StoreGate key *Cone4TowerParticleJets*, which satisfies:

1. Overlap removal with electrons: $dR(\text{electron}, \text{jet}) > 0.3$,
2. $|eta| < 2.5$,
3. $p_T > 25$ GeV.

Distributions of the dR, p_T, and η cut variables are shown on Fig. 3. *Show also* $d\varphi$*?*

(a) $dR(\text{electron}, \text{jet})$ (b) $|\eta|$ (c) p_T

Figure 2: Distributions of jet-to-electron distances in η, φ, and R, in overlap removal.



(a) (b)

Figure 3: Distributions of η (3(a)) and p_T (3(b)) of jet candidates. The η distribution includes only those the candidates that passed the p_T cut, and p_T distribution only the candidates that passed the η cut.

Event selection

Event selection cuts are designed to obtain an inclusive sample of $W^{\pm} \to e\nu$ events.

3 Calibrations and Efficiencies

3.1 Electron energy scale calibration

For electrons, we correct the electromagnetic energy scale of the release 12 simulation to agree with the scale observed in the streaming data. Before correction, a miscalibration is evident in the mismatched Z^0 mass peak in streaming data and in a PYTHIA $Z^0 \to e^+e^-$ sample[1], as shown in Figure 4.

emscaleMZbefore

Figure 4: Differences in the electron energy scale in streaming data and the release 12 simulation sample lead to a systematically shifted reconstructed Z^0 mass.

We assume that the effect of miscalibration can be represented by a factor which is independently a function of electron eta and energy, so the corrected energy can be written $E_{\mathrm{corr}} = \alpha(\eta, E) \cdot E_{\mathrm{sim}} \equiv \alpha_1(\eta)\alpha_2(E) \cdot E_{\mathrm{sim}}$. We then determine the correction factor $\alpha(\eta, E)$ by calibrating the position of the Z^0 mass peak in bins of η or E. The corrected Z^0 mass squared reconstructed with electron-positron pairs in a given bin would be written $\alpha(\eta_+, E_+)\alpha(\eta_-, E_-)M^2_{\mathrm{sim}}$. To measure the correction, we simply equate this with the mean value of M_Z^2 from the streaming dataset.

In Figure 5, the average value of $\frac{(M_{Z^0})^2}{8313.8}$ is plotted as a function of the electron or positron's energy and η for the streaming data and the release 12 simulation. The data distributions, proportional to $\alpha(\eta_\pm, E_\pm)\langle\alpha(\eta_\mp, E_\mp)\rangle$ for positrons (electrons), are independent of the charge of the lepton being averaged over. We combine the electron and positron plots to derive the calibration. The result is shown in Figure 6. The η and E distributions are consistent with a constant correction factor of 1.009 ± 0.001 in the range ($E > 25$) and ($0 < |\eta| < 1.3$ or $1.7 < |\eta| < 2.4$). We treat the variation of the correction in the cracks near $|\eta| = 1.5$ as a systematic errror.

emscaleEta

(a) Average Z^0 mass squared, scaled by 8313.8 GeV^2, *vs.* electron/positron η.

emscaleEn

(b) Average Z^0 mass squared, scaled by 8313.8 GeV^2, *vs.* electron/positron E.

Figure 5: Dependence on lepton kinematics of the reconstructed Z^0 mass in streaming data and release 12 PYTHIA Monte Carlo.

emscaleEtaR

(a) Derived energy correction as a function of electron η.

emscaleEnR

(b) Derived energy correction as a function of electron E.

Figure 6: Correction to the electron energy required for the release 12 simulation.

We may incur a systematic bias by assuming that the correction is flat in electron energy. Allowing a linear term in the fit to $\alpha(E)$, the correction varies by ${}^{+0.002}_{-0.001}$ in the range 0 to 101 GeV (which encompasses 90% of the leading electrons in selected events in the tt simulation). If we include the regions near the crack, ($1.3 < |\eta| < 1.7$), the derived correction shifts negligably by 0.004. We therefore combine a systematic error of 0.002 with the statistical error on the fit, so that the electromagnetic energy scale is known with a 0.22% relative systematic uncertainty.

[1] We use `trig1_misal1_mc12.005144.PythiaZee.recon.AOD.v12000604`.

3.2 Trigger Efficiency

Plots and Text: Andre

3.3 Other effects

3.4 Missing transverse energy scale

This section should move to systematics.

The missing transverse energy used to select $W^{\pm}$ candidates in this analysis is calculated from a sum over specifically calibrated calorimeter cells in three categories: cells in electromatic clusters, in jets, and in clusters not associated with any reconstructed calorimeter object [1]. This sum is then corrected for the E_T of identified muon candidates and for probable energy loss in the cryostat. Since the cell energies recieve either electromagnetic or hadronic energy scale corrections, a systematic miscalibration of the $\not{E}_T$ could result from miscalibrations of either scale, or of the muon identification efficiency.

As a first comparison of the scale of missing energy measurements in the release 12 simulation and the streaming data, we analyze the $W^{\pm}$ transverse mass distribution. This distribution is unaffected by differences in the $W^{\pm}$ boson kinematics, but other sources of true missing energy such as additional neutrinos or unidentified muons, will disort this distribution in the streaming data. We use the $t\bar{t}$ preselection (the lepton selecton with the requirement that only one tight lepton is found in the event, and the missing energy cut of 25 GeV) to select $W^{\pm}$ candidate events in the streaming data and a PYTHIA $W \to e\nu$ sample[2)] simulated in release 12.0.6. We apply the lepton energy scale correction derived in section 3.1. By requiring that the multiplicity of jets with p_T greater than 25 GeV be less than 2, we exclude most $t\bar{t}$ and other background events. The $W^{\pm}$ transverse mass reconstructed in each sample is plotted in Figure 7. The ratio between the mean $m_T(W)$ in the streaming data and the PYTHIA sample is 1.019 ± 0.001 when $N_{\text{jets}} = 0$ and 1.011 ± 0.003 when $N_{\text{jets}} = 1$.

metscale0

(a) $W^{\pm}$ transverse mass for events with $N_{\text{jets}} = 0$.

metscale1

(b) $W^{\pm}$ transverse mass for events with $N_{\text{jets}} = 1$.

Figure 7: Studies of $m_T(W)$ and $\not{E}_T$ scale in streaming data and the release 12 simulation.

This approach indicates a systematic uncertainty of about 3% for low jet multiplicities. However, the method is too sensitive to contamination by $t\bar{t}$ events to be used in the high jet multiplicity region, and comparision of the ratios determined in the 0- and 1- jet bins does not rule out a correlation with jet activity. To estimate a systematic uncertainty, we simply assume that the jet energy scale miscalibration is the dominant driver of the missing energy scale in events with a large jet multiplicity. We therefore assign the $\not{E}_T$ scale the same nominal 5% uncertainty as the jet energy scale. We then calculate the effect of such an uncertainty on the signal acceptance.

4 Signal Acceptance

4.1 Acceptance

Table: Andrei

Cut counting Plot (cumulative acceptance for MC@NLO)

* central val

2) We use `trig1_misal1_csc11.005100.JimmyWenu.recon.AOD.v12000601`, applying the "1mm" bug correction in the AOD [2].

Missing E_T scale	Lepton+jets acceptance	relative change
1.05	0.054 ± 0.01	+4%
0.95	0.050 ± 0.001	-4%

Table 1: The acceptance of our event selection (excluding trigger requirements) with different missing energy scale settings.

Generator	acceptance
ACERMC	0.0524 ± 0.00
MC@NLO	0.0524 ± 0.00

Table 2: The acceptance of our event selection (excluding trigger requirements) for events generated with MC@NLOand ACERMC.

5 Backgrounds

5.1 Electroweak backgrounds

* W+jets: — now this is 'Electroweak' Andrei Plots and Tables and Text ** Normalization (e.g. cross section) W Cross Section Cross Check MDS must subtract Z and Tau cross section ** acceptance (after corrections) Andrei Cut plots

5.2 Single top

* Single top — just added Have plots with Default MC (ACER) Need to think about systematics

5.3 Fake electrons

* (neglect fakes) Plots from Andre to show that Fakes are small

6 Cross section or Method or whatever

6.1 Without fit method

6.2 Fit method

7 Systematic uncertainties

7.1 Signal modeling systematics

7.1.1 Monte Carlo Generator

We use MC@NLO [3] version 3.1, with Jimmy [4] showering, to generate the $t\bar{t}$ signal events and determine our acceptance. This generator includes all terms in the matrix element up to order α_s^3, but neglects some observable angular correlations. As a very crude estimate of the theoretical uncertainty, we compare the acceptance calculated above to the acceptance derived with ACERMC , which uses a leading-order calculation of $t\bar{t}$ production and PYTHIA showering.

Sample	PYTHIA settings	acceptance
AcerMC “low m_T”		9.3
AcerMC “high m_T”		7.8

Table 3: Signal acceptance (from ATLFAST) in ISR/FSR systematic samples.

7.1.2 Initial and final state radiation

Uncertainty in the modeling of initial and final state radiation affects the average number of jets above threshold in top events, and thus the acceptance of our event selection (especially the final $N_{\mathrm{jet}} > 3$ requirement). Here, we compare the signal acceptance calculated using three samples with different initial and final state radiation settings. The acceptance was calculated using ATLFAST rather than fully reconstructed samples.

** Systematics: 1-2 jet comparison Big Discussion Still underway: Joe, Peter, Andrei and Andre

Z vs W. Can use Z in higher Nj bins to estimate the background without being affected by ttbar. But need W/Z ratio and systematic on it.

8 Results

As noted above, we observe 490 ttbar candidate events in the 15.03 pb^{-1}

** summary of systematic errors Review of above (Table)

* Cross section, given ”all-top” hypothesis Andrei

9 Future refinements

* Consistency checks with all-top hypothesis ¡== including btags, dileptons, sumET, etc?

* Refinement of Analsysis

- Dileptons

- BTagging

10 Acknowledgements

References

[1] S.L. Glashow, Nucl. Phys. **22** (1961) 579.

[2] ”NewsForPhysicsUsers, https://twiki.cern.ch/twiki/bin/view/Atlas/NewsForPhysicsUsers”.

[3] S.L. Glashow, Nucl. Phys. **22** (1961) 579.

[4] S.L. Glashow, Nucl. Phys. **22** (1961) 579.